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# Road accidents, an occupational risk

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## **Abstract**

Road accidents sustained at work represent between 20% and 40% of work fatalities in most industrialised countries, yet few data on occupational road accident risk factors have been published. A case control study was performed to assess the role of work-related risk factors in the occurrence of occupational road accidents. A preliminary qualitative study was carried out to identify possible occupational factors in occupational road accidents, and to draw up the case control study. Cases were recruited from the Rhône Road Trauma Registry (France), controls from voting lists. A telephone interview was performed. Exposure to road risk was measured as a percentage of work time. One hundred and forty-six cases and 440 matched controls were interviewed. Accident risk was found to increase with exposure. Driving was associated with more difficult working conditions than found in jobs not involving driving. These difficulties, however, were not systematically associated with increased occupational road accident risk. Among factors which still emerge after adjustment for road risk exposure, there are scheduling issues (inflexible schedule organisation, lack of consecutive rest-days, lack of flexibility in performing the work), difficulties of communication with superiors, low seniority in the activity, low educational level and physical constraints at work. This study highlights some possible occupational road accident risk factors. Given the chosen case/control methodology, the findings may be considered as advancing our knowledge of the subject, but need confirmation by further studies.

**Key words:** work accident, risk factor, road accident, working conditions

## **1. Introduction**

Road accidents sustained while the victim is at work on behalf of his or her employer represent between 20% and 40% of work fatalities in most industrialised countries, yet have been the object of only a few reports. Some descriptive studies have provided figures for such accidents (Harrison et al., 1993; Trent, 1989; Toscano and Windau, 1994; Rossignol et al., 1993; Charbotel et al., 2001; Pratt, 2003).

In view of the large number of occupational road accidents, their frequent seriousness compared to other work accidents, the existence of intrinsic professional factors in certain cases (e.g., heavy goods vehicle drivers) and the lack of studies regarding other job-categories such as executives and office workers, it seemed vital to improve our knowledge of the issue. This was the objective of the present original study, comparing a group of occupational road accident victims with a control group of subjects drawn from the general population.

The objective was to identify and quantify the possible role of work-related risk factors in the occurrence of occupational road accidents.

## **2. Material and Methods**

### **2.1. Preliminary qualitative study**

A preliminary qualitative study had been performed to identify possible occupational factors in occupational road accidents, to draw up the questionnaire of the present study (Davezies and Charbotel, 2005). Telephone interviews were carried out with 26 victims of occupational road accidents identified from the road trauma registry of the Rhône administrative *département* (France) (Laumon et al., 1997; Charnay and Laumon, 2002, Amoros et al. 2006). The aim of this preliminary study was to identify elements specific to driving at work. Analysis thus went beyond the usual road accident study parameters, which focus on the

immediate conditions of the accident as such (condition of driver, vehicle and road), and sought out more upstream factors of work organisation.

## **2.2. Subject recruitment for the case control study**

Occupational road accident victims were recruited from the road trauma registry of the Rhône administrative *département* (France) (Laumon et al., 1997; Charnay and Laumon, 2002, Amoros et al. 2006). Commuting accidents were excluded. A letter was sent to the victims asking them to participate in the study. A second letter was sent if there was no reply in the following month. Accident victims were interviewed within 3 months of the date of their accident. Only driver, motorcyclist, cyclist and pedestrian victims were included: it seemed difficult to assess the impact of working conditions in the case of passengers not “actively” involved in the accident.

For each occupational road accident victim, 4 controls, in employment and accident-free for the previous year, were sought from the general population, using the electoral voting lists of the locality of residence of the corresponding case. The matching criteria were the locality of residence, sex and age (year of birth  $\pm$  2 years). Controls were randomly selected from the electoral lists using a random number table. The contact procedure was the same as for cases.

## **2.3. Data collection**

Telephone interviews were carried out by the same interviewer for cases and controls. As well as working conditions, questions concerned the company in which respondents were working at the time of the accident (size and sector) and their job (title and description).

The questionnaire included questions drawn up to explore job characteristics, schedules, physical constraints, means available at work, and subjective relation to work. Whereas in the qualitative study questions were open so as to explore all of the possible factors of the accident, in the case/control study very closed questions were used leaving little room for interviewer interpretation.

On the basis of responses regarding job title and associated tasks, respondents' jobs were coded according to the INSEE classification (Profession and Socioprofessional Category codes: PCS 2003) to enable comparison with the general population. Likewise, company business was coded according to the NAF (French Business Names) system (NAF version 1, 2003).

Exposure to road risk was expressed as a percentage of work time and comprised working time spent travelling for the job as driver, motorcyclist, cyclist or pedestrian.

#### **2.4. Data analysis**

Victims and matched controls were compared using the McNemar matched test for dichotomous nominal variables, the Stuart–Maxwell test for nominal variables of more than two modalities.

The statistical analysis used to determine the risk factors associated with a road accident occurring in a work context was of the matched case-control type based on a conditional logistic regression. Maximum likelihood estimates of odds ratios and 95% confidence intervals (CI) were calculated using the logistic procedure and strata option of SAS (Stokes, 2002). Occupational risk factors were adjusted for exposure to road risk. As the assumption of linearity of exposure for road risk was not confirmed, exposure was discretized into four ordinal categories.

A multivariate logistic regression was performed with manual backward selection. Only risk factors that proved significant after adjustment for exposure to road risk were included. Certain socio-professional and job sector categories were excluded because of their relationship with working conditions.

The significance threshold was set at 5%. All analyses used SAS® software.

### **3. Results**

#### **3.1. Inclusion**

Four hundred and fifty eight victims of work-related road accidents were identified from the Road Trauma Registry of the Rhône administrative *département*. Three hundred and thirty eight of them had been identified by the Registry as being on duty at the time of the accident, whereas this detail was unknown for 120 (on duty / commuting). For 31 of the victims, the letter inviting them to participate was returned by the Post as “Not living at this address”. One hundred and one of the victims informed us that the accident had not occurred while they were on duty, and 46 replied but refusing to participate. Finally, 146 cases were interviewed. The participation rate among cases was therefore 45%.

A total of 2,060 persons were identified from the electoral files to match the inclusion criteria. Four hundred and thirty eight of these were not residing at the given address, 102 did not match the criterion “in employment and accident-free for the previous year”, and 63 refused to participate. Finally, 440 matched controls were interviewed. The participation rate among controls was therefore 29%.

General characteristics of the population are presented in Table 1.

#### **3.2. Occupational road risk exposure**

More than 50% of controls were not exposed to road risk (see Table 2). Some cases also claimed not to be exposed inasmuch as they travelled only very occasionally, making quantification difficult; but cases were generally much more exposed than controls. Accident risk increased with exposure.

#### **3.3. Descriptive analysis**

##### **3.3.1. Educational level**

Cases had a generally lower educational level than controls, 55.4% having school-leaving certificates below the Baccalauréat level, as against 30.3% of controls; 32.0% of controls vs.

11.5% of cases had at least 2 years' higher education, and 37.7% (vs. 33.1% for cases) had a Baccalauréat and up to 2 years' higher education.

Taking subjects with some higher education as reference category, a significantly greater risk emerged in subjects having school-leaving certificates below the Baccalauréat level: adjusted OR=2.81 [95% CI, 1.29-6.15].

### **3.3.2. Job and sector (Table 3 and Table 4)**

The largest group of victims was manual workers. Twenty of the 61 manual worker victims were truck drivers, 16 delivery persons, 6 public transport drivers, 3 refuse disposal operatives, 2 machine drivers and 1 car driver; the other 13 comprised 2 metallurgy workers, 2 maintenance operatives, 2 fork-lift drivers, 1 storekeeper, 1 construction worker, 1 waste disposal operative and 4 unskilled labourers.

Nearly a quarter of victims worked in the public sector: 12 postal workers, 6 ambulance crew members, 4 local police, 4 security agents, 2 national police (*gendarmes*), 1 soldier, 1 cash transport operative, 1 nursing auxiliary and 1 school janitor.

Taking executives and self-employed as reference category, the highest occupational road accident risk level was for public sector workers, followed by manual workers, craftsmen, shopkeepers and company directors, then middle-level private sector workers. Risk, at around 2, was non-significant for the other groups identified on analysis.

Taking industrial work as reference, inter-sector comparison found a high occupational road accident risk in transport and communications, even after adjustment for road risk exposure. Shops and restaurants were also associated with increased occupational road accident risk. Adjusted ORs for the other sectors were slightly greater than 1.

### **3.3.3. Work contract**

Accident victims were more often on permanent contracts (68.5% vs. 62.9% for controls); less than 10% of both cases and controls were on non-permanent contracts. There were fewer



public sector *fonctionnaires* among the cases: 8.9% vs. 15.9% of controls. 7.5% of cases and 5.4% of controls were self-employed. 6.2% of cases and 6.6% of controls had other kinds of work contract under French law.

Taking non-permanent contracts as reference category, no increased risk emerged for the other categories. Being a *fonctionnaire* had a tendency to reduce risk, but insignificantly. After adjustment for exposure, having a permanent work contract showed a tendency to reduce risk, but again insignificantly.

#### **3.3.4. Company size**

Occupational road accident victims worked in smaller sites than did controls (see Table 5). Adjusting for exposure, however, showed these differences to be non-significant.

#### **3.3.5. Seniority**

Occupational road accident victims tended to have less seniority than controls: almost half had been in their company for less than 2 years, versus one third of controls. A similar trend was found for seniority in the job and in the type of job (Table 6). In all seniority brackets, accident risk tended to be inversely proportional to seniority. Taking the maximum seniority bracket as reference, the only significant difference was for the lowest seniority bracket in each category: for less than one year in the job, for less than 3 years in the type of job, and for less than 2 years in the company.

After adjustment for road risk exposure, seniority in the job showed no effect. In contrast, increased risk persisted between those with less than 3 and those with more than 17 years in the same type of job. The risk associated with having been less than 2 years in the company was close to significance with reference to the category of having been more than 12 years in the company.

### **3.3.6. Working conditions**

#### **3.3.6.1. Work time**

Work schedules were less flexible for cases than controls: 63.7% of cases versus 47.5% of controls had schedules set by the company; controls were more likely to have the choice between fixed times (9.1% vs. 7.5% of cases), flexi-time (10.7% vs. 5.5%) or even free schedules (32.7% vs. 23.3%). After adjustment for exposure, road accident risk was twice as great when schedules were set by the company: adjusted OR= 2.33 [95% CI, 1.23–4.40].

The consequences of being late for work were more serious for cases than controls: 29.4% claimed this would cause problems with superiors, compared to only 11.4% of controls. Lateness was also more likely to cause problems with the public – for 15.1% of cases, versus 6.1% of controls. After adjustment for exposure, these differences remained significant: the adjusted OR associated with problems with superiors in case of lateness was 3.71 [95% CI, 1.93–7.12] and, with the public, 2.36 [95% CI, 1.07–5.18].

Controls had more information about schedules over the coming days, weeks and months than did cases. Ninety one point eight percent of controls knew their schedule for the day ahead, versus 84.9% of cases, and 80.0% vs. 67.8% for the week ahead; however, adjustment for exposure made the corresponding odds ratios non-significant, and these elements do not feature as occupational road accident risk factors.

Changing their schedule was easier for controls than cases (70.2% vs. 59.6%;  $p=0.002$ ). After adjustment for exposure, occupational road accident risk tended to be greater when schedules could not be negotiated with colleagues, but not significantly: adjusted OR=1.66 [95% CI, 0.96–2.87].

Cases more frequently worked nights than controls (30.8% vs. 19.1%;  $p=0.007$ ), and less often had 2 consecutive days' rest (30.8% vs. 15.7%; adjusted OR=2.14 [95% CI, 1.18–3.88]).

Working weekends, working nights, and not having 2 consecutive days' rest were consolidated in a single variable, which concerned 30.1% of cases and 15.0% of controls, with an adjusted OR of 2.34 [95% CI, 1.26–4.31].

### **3.3.6.2. Work rhythm**

Cases more frequently reported being subject to hourly (49.0% of cases, vs. 42.1% of controls) or daily productivity goals (71.7% of cases vs. 67.7%), whereas controls were governed more by colleagues (25.2% of controls vs. 19.7% of cases) or external demand, which could be immediate (for 54.3% of controls vs. 52.4% of cases) or not (65.9% of controls vs. 53.1% of cases). Work rhythm was rarely determined, be it for cases or controls, by automated movement of parts (respectively, 2.8% and 1.6%) or a machine (respectively, 2.1% and 2.9%), although both cases and controls were under an obligation to work fast (respectively, 84.1% and 88.2%). Cases tended to feel more under surveillance by superiors (35.2%, vs. 26.2% for controls). These differences between cases and controls were not significant.

There was no difference with respect to computer surveillance, affecting 29.0% of cases vs. 28.2% of controls. Only 13.8% of cases reported their work rhythm to be governed by technical factors, versus more than one in five controls (21.9%); this difference proved statistically significant.

### **3.3.6.3. Support, autonomy and means available at work**

One third of both cases and controls claimed not to have enough time to do their work. Simultaneously meeting both time and quality goals, however, was often or always impossible for 13.1% cases (vs. 6.2% for controls: raw OR=2.48 [95% CI, 1.22-5.02]), taking as reference category subjects who reported they never encountered this difficulty; but the adjusted OR was not significant: OR=2.18 [95% CI, 0.91–5.25].

Cases more often than controls claimed to receive contradictory orders: adjusted OR=2.40 [95% CI, 1.09-5.27]. About one third of both cases and controls claimed to receive unclear or insufficient information (respectively, 29.7% and 32.1%) and always to have to deal with tricky situations on their own (respectively, 34.9% and 26.6%). After adjustment on exposure to road risk, no increased risk was identified. Only a very few reported concealing how they actually worked.

Cases reported having appropriate software (30.3% vs. 58.6%) or equipment (71.0% vs. 80.2%) available less often than controls; the raw odds ratio associated with not having appropriate software was 2.16 [95% CI, 1.19–3.91], which was not significant after adjustment: adjusted OR=1.69 [95% CI, 0.79–3.65]. Many cases, on the other hand, reported not being concerned by software (55.2% vs. only 28.2% of matched controls).

There was no difference with regard to job entry training: only one in five subjects claimed not to have had sufficient or appropriate training.

#### **3.3.6.4. Fatigue management**

Controls reported greater flexibility in performing their work than cases: they could choose task order (77.5% vs. 51.4%) and rhythm (77.2% vs. 48.6%) and could more freely take a break (75.2% vs. 67.1%). They more often had the possibility of taking work home. After exposure adjustment, imposed task order and rhythm were associated with increased occupational road accident risk (adjusted OR 2.62 [95% CI, 1.48–4.63] and 3.14 [95% CI, 1.78–5.53], respectively). Conversely, the possibility of taking work home was associated with significantly decreased risk: adjusted OR=0.36 [95% CI, 0.18-0.72].

#### **3.3.6.5. Teamwork and communication**

Cases more often than controls claimed never to get help from colleagues (23.3% vs. 11.8%), superiors (35.6% vs. 26.6%), other persons in the company (60.3% vs. 47.5%) or persons outside the company (63.7% vs. 53.4%); 17.2% of cases, versus 9.1% of controls, considered

cooperation at work impossible. One third of both cases (31.7%) and controls (35.7%) felt they did not have enough people cooperating with them.

Occupational road accident risk was significantly increased by impossibility of cooperation (raw OR=2.14 [95% CI, 1.21–3.78]) or lack of help from colleagues (raw OR=2.49 [95% CI, 1.31–4.73]), although these differences were not significant after adjustment for road risk exposure.

Difficulty of communication with superiors tended to be more frequent in cases than controls. This was a matter of failing to understand superiors (21.2% of cases vs. 14.8% of controls) or of being understood by them (17.1% of cases vs. 10.4% of controls); these factors were respectively associated with raw ORs of 1.57 [95% CI, 0.96–2.57] and 1.85 [95% CI, 1.08–3.15]. After exposure adjustment, difficulty in understanding superiors was associated with a significant risk (adjusted OR=2.24 [95% CI, 1.14–4.38]), unlike that of being understood (adjusted OR=1.85 [95% CI, 0.92–3.74]).

In contrast, cases reported less difficulty than controls in communicating with outside persons, whether in understanding them (16.4% vs. 23.9%) or in being understood (14.4% vs. 15.2%), although these differences were not significant after adjustment. Difficulties of communication with colleagues were, at around 5%, more or less equally rare for both cases and controls.

Cases experienced tension with superiors more often than controls, but this tension was inherent to driving inasmuch as the difference from controls disappeared on adjustment. Tension with colleagues, subordinates and the public did not differ between cases and controls.

#### **3.3.6.6. Physical factors and discomfort**

Cases more often reported physical difficulties at work: uncomfortable posture (61.6% vs. 47.1% for controls), carrying heavy objects (52.0% vs. 35.0%), and painful movements

(41.8% vs. 28.0%). After exposure adjustment, only carrying heavy objects proved significantly correlated to occupational road accident risk: adjusted OR=1.76 [95% CI, 1.06–2.92]

Cases also claimed to be more exposed to dusty or smoky atmospheres (43.1% vs. 33.9%), dirt, damp, draught and bad smells. After road risk exposure adjustment, only exposure to dirt, draught and bad smells proved significant: adjusted ORs respectively 2.39 [95% CI, 1.24–4.64], 3.74 [95% CI, 1.57–8.91] and 3.15 [95% CI, 1.41–7.00].

Cases tended to report more temperature discomfort than controls, whether for high (30.1% vs. 20.0%) or low temperature (26.0% vs. 13.9%). After adjustment, only exposure to low temperatures proved significantly correlated to occupational road accident risk: adjusted OR=2.23 [95% CI, 1.18–4.19].

Finally, cases reported being more often subject to verbal aggression than controls, although this factor was not significant after adjustment on exposure to road risk.

### **3.3.7. Health and safety**

Cases and controls did not differ in their employers' management of workplace risk. Less than a third considered themselves informed; only 19% claimed to have had in-service risk management training. 46% of cases and 51.5% of controls reported a document on workplace risk on site (mandatory in France). The two groups tended to differ a little more when it came to health and safety recommendations at work, considered applicable by 98.5% of controls versus only 89.1% of cases, although this difference was not significant ( $p=0.2$ ).

### **3.3.8. Attitude to work**

Cases more often than controls tended to complain of “being exploited”, “boredom”, “being replaceable”, whereas controls in contrast tended more often to speak of “recognition” and “pleasure”. Lack of recognition was associated with a significantly high raw OR of 2.14 [95% CI, 1.32–3.47], but adjustment brought this down to a non-significant 1.46 [95% CI,

0.79–2.68]. Likewise, for feeling “always” exploited the raw OR was 3.40 [95% CI, 1.54–7.53], but after adjustment, while greater than 2, was not significant.

In terms of overall satisfaction, 42.5% of cases (vs. 33.5% of controls) claimed to be generally satisfied by their work; 45.9% (vs. 60.6% of controls) were neither satisfied nor dissatisfied (neutral feeling towards work), and 11.6% (vs. 5.9% of controls) were dissatisfied. The raw OR associated with dissatisfaction was 2.32 [95% CI, 1.17–4.59], non-significant after adjustment.

Fifty seven and six percent of cases reported receiving no overtime compensation, compared to 50.6% of controls; this difference was not significant ( $p=0.3$ ).

Cases more frequently reported fearing for their job: 32.3% vs. 20.7% of matched controls;  $p=0.01$ . After exposure adjustment, such fear was twice as frequent in cases as controls, adjusted OR=2.13 [95% CI, 1.20–3.77].

Twice as many cases as controls described their job as a man’s job, both from their own point of view and from that of the firm; this difference, however, was significant only for the employee’s own point of view: adjusted OR=2.23 [95% CI, 1.20–4.13].

### **3.4. Multivariate analysis**

At the last step of the descending logistic regression, 6 occupational factors were included. Risk was still higher for less than 3 years’ seniority in the same type of job compared to more than 17 years’, but this was not statistically significant. All of the other five factors were statistically significant: an increased risk was observed among those reporting difficulties with superiors in case of lateness, with an OR reaching 4.96 [95% CI, 2.11-11.68]; imposed task order was associated with an OR of 3.07 [95% CI, 1.51-6.22], and carrying heavy objects with an OR of 2.32 [95% CI, 1.22-4.41]. The risk of accident still increased with the exposure split into four categories. In contrast, a protective effect was observed among workers reporting the possibility of taking work at home: OR=0.37 [95% CI, 0.16-0.81].

#### **4. Discussion**

Very few data on occupational road accident risk factors have been published. Some qualitative approaches have been developed in programmes for work-related road accidents in the UK. The Department of Transport identified fatigue, pressure, training, planning, incident management and communications as the most critical factors for the management of occupational road risk (HMSO, 2004). Time pressure, tiredness, thinking about work while driving, and use of mobile phones were shown to be risk factors in driving during working hours (Salminen and Lahdeniemi, 2002). To the best of our knowledge, the present case/control study is the first study of the relation between working conditions and occupational road accident risk published in the general population. A cohort study recently published included employees of the French national electricity and gas companies and described two indicators of self-reported work fatigue associated with the occurrence of at-work crashes: “nervously tiring work” for males, and sustained standing for females (Chiron et al., 2008).

The purpose of the present study was not to investigate the usual factors of crashes, such as age, gender or attitudinal or personality traits which may be linked to accident involvement. Our hypothesis was that some attitude or human factors may actually be influenced by working conditions. As age and gender are well-known factors of accident involvement, especially for crashes occurring during work, cases and controls were matched on age and gender. To explore the influence of occupational constraints, the best design would be a longitudinal follow-up of workers occupationally exposed to road risk. Considering the frequency of crashes, this type of study would require involving thousands of workers and would have to be justified by preliminary work. For this reason and because in the Rhône Region there exists a road trauma registry, it seemed relevant to explore this new field of research by performing a case/control study.



The study does, however, have the limitations inherent to the chosen methodology. The main bias inherent to case/control studies lies in the fact that respondents are aware of their status as case or control, which may affect their responses. This is especially true in the case of factors generally known to represent road accident risks or which involve infringement of the Highway Code. Such bias, on the other hand, was probably less strong in the case of work-related factors, which subjects could not so easily link to the accident they had had. Indeed, during interviews, the accident victims quite often asked why the interviewer was “asking all these questions that have got nothing to do with the accident”.

Interviewer-bias, while not to be neglected, was limited by the use of very closed questions leaving little room for interviewer interpretation.

Another limitation of the study is the participation rate. At 45% for cases and 29% for controls it cannot be said to have been good, but was in line with that of other studies using postal recruitment (Boeing et al., 1999; Eastwood et al., 1996; Salminen and Lahdeniemi, 2002). The difficulty was heightened by the fact that the population was young, mobile and not very available.

Controls were generally less occupationally exposed to road risk than cases, 53.7% claiming not to be exposed compared to only 11.6% of cases. This corresponds to the non-zero road risk, however slight, run by any employee, and which is no doubt dependent on the type of job. Road risk exposure in itself is obviously a determining factor in the incidence of road accidents. While not strictly linear, risk exposure increases with increasing annual distance travelled (Peck and Kuan, 1983; Massie et al., 1997). Adjusting for this variable was therefore essential in analysing the various road accident risk factors under study.

In the SUMER 2003 assessment of a representative sample of the general population of French employees' exposure to various work-linked risks, only a quarter (25.4%) of employees claimed to be exposed to road risk (Arnaudo et al., 2006). There were, however,

sex-linked differences, with 36% exposure in men and only 14% in women (Arnaudo et al., 2005). This makes our control subjects more exposed, at 46.8%, to road risk than the French population as a whole. In this respect, it should be borne in mind that our controls were mainly young males, whereas in the SUMER study 41% of those exposed were under 30 and 27.1% between 30 and 39 years of age. The proportion of controls exposed to road risk during more than half of their working time (6.8%) was similar to the findings of the SUMER study (7.7%).

Accident victims worked in smaller companies than controls. There would thus appear to be an increased road accident risk for those working in companies with less than 50 employees or at sites with less than 10 employees, with respective raw ORs of 1.96 [95% CI, 1.25–3.08] and 2.24 [95% CI, 1.31–3.85]. After adjustment for exposure, however, these odds ratios become non-significant, at respectively 1.28 and 1.09. Thus the increased occupational road accident risk related to company size is in fact due to the increased frequency of high exposure in small structures. The data of the Rhône-Alpes Public Health Insurance Authority (CRAM) confirm that the work accident risk in small and medium-sized companies is generally high: in 2005, the work accident frequency index (i.e. [number of work accidents leading to sick-leave/number of employees] x 1000), taking all circumstances together, was 53.2 for companies with 10 to 49 employees and 51.2 for those with 50 to 199, compared to 6.9 for companies with over 1,500 employees (CRAMRA, 2005).

An analysis of fatal accidents managed by the National Research and Safety Institute (INRS), also disclosed high road risk exposure in small companies (Richez and Tissot, 2001): 67% of fatal occupational road accidents recorded for the period 1990-1997 concerned companies with less than 50 employees, and 31% companies with less than 10 employees. In 2004, 45.8% of French employees worked in companies with less than 50 employees and 19.8% in companies with less than 10 employees (INSEE, 2007).

Taking executives and self-employed as reference, public sector workers have a high road risk exposure, close to that of manual workers, a category that includes professional drivers. Professional drivers are already targeted by professional road risk prevention measures, but it would seem to be necessary to extend this to public sector workers – especially in the postal service, as 12 of the 33 public sector occupational road accident victims were postal workers.

The present study also found a low educational level to be associated with an increased occupational road accident risk. These findings are coherent with our cases being more frequently manual or office workers, whereas controls tended to be executives.

Having recently started a new job (hiring, new contract, new position, or new workplace) is a factor known to increase work accident risk in general (Benavides et al., 2006). A 1998 study of a representative sample of 22,000 subjects found the rate of work accidents to be inversely proportional to seniority, all other risk factors being equal (Dares, 2002): from 11.4% with less than 2 years' seniority, it gradually fell to 6.8% after 10 years; i.e., seniority of 10 years or more would seem to protect against work accident risk. Likewise in the present study, occupational road accident risk decreased with increasing seniority.

Work time has changed since the early 1980s, the working week getting shorter while time pressure has increased (Bué and Rougerie, 1999a), and schedules have become more irregular and diverse (Bué and Rougerie, 1999b). Repercussions on health have been described, notably in terms of “mental load” (Hamon-Cholet, 2002); the preliminary qualitative phase of this epidemiological study also noted high time-constraint exposure among certain occupational road accident victims, who seemed to be more frequently exposed to unusual schedules (working Saturdays, Sundays and/or nights), although these factors did not actually increase occupational road accident risk after adjustment for road risk exposure. I.e., such poor working conditions were inherent to driving as such. Not having two consecutive days' rest, on the other hand, did increase occupational road accident risk.

Cases had less choice in their schedules than controls. Schedules being set by the company was associated with increased occupational road accident risk. Cases more often reported being unable to negotiate schedules with their colleagues, and the exposure-adjusted OR was close to significance. Cases more often reported difficulties in case of lateness, whether with superiors or with the public. Inflexible schedules may thus increase occupational road accident risk. This is occurring in an economic context of a reduction in the working week, with growing formalisation of schedules and time control (clocking and signing on), increasing pressure on employees, especially below the executive level (Estrade and Ulrich, 2002).

The present study found a significant increase in occupational road accident risk with inability to choose one's own work rhythm and task order. Lack of autonomy likewise featured as a work accident risk factor in the 1998 survey of working conditions (Dares, 2002), despite the fact that the preliminary qualitative study stressed that occupational driving required adaptability (Davezies and Charbotel, 2005). These findings indicate that work organisation needs rethinking in order to improve occupational road accident prevention.

Cases in the present study did not report an "obligation to work fast" more often than controls. Two thirds of subjects said they had "enough time to do the work". Being "unable simultaneously to meet quality and time objectives", on the other hand, was more frequently reported by cases, although the adjusted OR, while tending to be high, was not significant.

The technical means available to the employee are an important component of working conditions. More than half of cases did not need software in their work, and cases were not more likely than controls to report lacking adequate training. Subjects exposed to road risk more often claimed not to have adapted equipment, although this did not significantly increase occupational road accident risk.

Cases more often than controls reported tension with superiors and receiving contradictory orders; only receiving contradictory orders was associated with increased occupational road accident risk, and had also been reported as increasing work accident risk in the 1998 survey (Dares, 2002). Tension with the public or colleagues, on the other hand, did not differ between cases and controls. Difficulty in communicating with superiors was reported more often by cases than controls, whether difficulty in understanding superiors or in being understood. The possibility of communicating with other persons at work (colleagues, subordinates and outside persons), on the other hand, did not differ between cases and controls. Such difficulties in communication could hinder in-service occupational road risk prevention campaigns. Over and above any technical training (road safety or vehicle maintenance), ways of improving employee-management dialogue on road accident prevention and work organisation issues need to be put forward. This could complement the measures already undertaken which have enabled the human and material scourge of occupational road accidents to be significantly reduced. Ergonomists have suggested a more ergonomic approach, arguing that, while behavioural factors underlie 80% of accidents, a more positive approach to work would show that operators improve their skills and adopt more prudent behaviour patterns (EUROGIP, 2003a). A psychodynamic analysis of work in relation to occupational road accidents could complement this ergonomic approach by actively involving drivers and enabling them to contribute their experience to a discussion of work organisation. This preventive strategy could, in particular, be proposed to small and medium-sized firms, in which road accident prevention needs developing (EUROGIP, 2003b).

As well as organisational constraints, physical constraints in the working environment are very frequently reported by road accident victims: uncomfortable posture, painful movement, damp, smoke and dust. Our study population largely consisted of young men, generally more

exposed to physical effort than older employees. Risk and physical effort are known to be indicators of accident-prone work situations, and the 1998 survey confirmed this (Dares, 2002), highlighting moreover a link between the number of professional constraints and the rate of work accidents. Skilled workers, for example, reported at least 6 work-related risks and above-average effort, and were almost twice as prone to accidents as the average. The present study seems to extend these findings to occupational road accidents: exposure to physical hardship appears as an occupational road accident risk factor.

Cases more often than controls claimed to “fear for their job in the year to come” (32.3% vs. 20.7%); these percentages were, however, much lower than those reported in the working conditions surveys, where such fear was expressed by 60% of employees in 1998, up from 46% in 1991.

## **5. Conclusion**

This study highlighted certain possible occupational road accident risk factors. Given the chosen case/control methodology, the findings may be considered as advancing our knowledge of the subject, but need confirmation by further epidemiological studies. They do, however, already indicate approaches to corporate road risk prevention. Small and medium-sized firms need to be better informed, so that prevention campaigns can be set up in them too. Overall, driving is associated with more difficult working conditions than found in jobs not involving driving. These difficulties, however, are not systematically associated with increased occupational road accident risk. Among factors which still emerge after adjustment for road risk exposure, there are scheduling issues: inflexible schedule organisation, lack of consecutive rest-days, lack of flexibility in performing the work, and there are difficulties of communication with superiors, a low seniority in the activity, low educational level and physical constraints at work.

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## **Legal agreements**

Approval by the French Ministry of Research (*Comité consultatif pour le traitement de l'information en matière de recherche dans le domaine de la santé*) and the French data protection authority (*Commission Nationale de l'Informatique et des Libertés*) was obtained before starting the study.

## References

- Amoros, E., Martin, J.L., Laumon, B., 2006. Under-reporting of road crash casualties in France. *Accid Anal Prev.* 38(4):627-635.
- Arnaudo, B., Magaud-Camus, I., Sandret, N., Coutrot, T., Floury M.C., Hamon-Cholet, S., Waltisperger, D., 2005. Exposition aux risques et aux pénibilités du travail de 1994 à 2003. Premiers résultats de l'enquête SUMER 2003. Document pour le médecin du travail. N°101. 2005. 11 pp.
- Arnaudo, B., Magaud-Camus, I., Sandret, N., Coutrot, T., Floury, M.C., Hamon-Cholet, S., Waltisperger, D., 2006. Les expositions aux risques professionnels. Les ambiances et contraintes physiques. Dares. Document d'étude. n°115. 250 pp.
- Benavides, F.G., Benach, J., Muntaner, C., Delclos, G.L., Catot, N., Amable, M., 2006. Associations between temporary employment and occupational injury: what are the mechanisms? *Occup Environ Med.* 63(6):416-421.
- Boeing, H., Korfmann, A., Bergmann, M.M., 1999. Recruitment procedures of EPIC-Germany. European Investigation into Cancer and Nutrition. *Ann Nutr Metab.* 43(4):205-215.
- Bué, J., Rougerie, C., 1999a . L'organisation des horaires de travail : un état des lieux en mars 1998. Premières synthèses, n°30-1, DARES.
- Bué, J., Rougerie, C., 1999b. L'organisation du travail : entre contraintes et initiative (résultats de l'enquête sur les conditions de travail de 1998). Premières synthèses, n°32-1, DARES.
- Charbotel, B., Chiron, M., Martin, J.L., Bergeret, A., 2001. Work-related road accidents in France. *Eur J Epidemiol* 17(8):773-778.



- Charnay, P., Laumon, B., 2002. Le registre des victimes d'accidents de la circulation routière du Rhône; modalités de mise en place, de recueil, d'informatisation et de gestion. Rapport UMRETTE n° 0204, octobre 2002. 119 pp.
- Chiron, M., Bernard, M., Lafont, S., Lagarde, E., 2008. Tiring job and work related injury road crashes in the GAZEL cohort. *Accid Anal Prev.* In Press.
- CRAMRA., 2005. Les accidents du travail, les maladies professionnelles, les accidents du trajet. Rhône-Alpes 2005.  
[http://www.cramra.fr/entreprise/risquesprof/pdf/pre022\\_0806.pdf](http://www.cramra.fr/entreprise/risquesprof/pdf/pre022_0806.pdf)
- Dares., 2002. Accidents, accidentés et organisation du travail. Résultats de l'enquête sur les conditions de travail de 1998. Premières Synthèses. Mai 2002. N°20.1. 10 pp.
- Davezies, P., Charbotel, B., 2005. Pré enquête sur les accidents de la route dans le cadre du travail. Préparation d'une enquête épidémiologique. Rapport UMRESTTE n°0501. 67 pp. [http://www.inrets.fr/ur/umrestte/publications/0501-Davezies\\_Charbotel.pdf](http://www.inrets.fr/ur/umrestte/publications/0501-Davezies_Charbotel.pdf)
- Eastwood, B.J., Gregor, R.D., MacLean, D.R., Wolf H.K., 1996. Effects of recruitment strategy on response rates and risk factor profile in two cardiovascular surveys. *Int J Epidemiol.* 25(4):763-769.
- Estrade, M.A., Ulrich, V., 2002. La réorganisation des temps travaillés et les 35 heures : un renforcement de la segmentation du marché du travail. *Travail et Emploi.* 92: 71-90.
- Eurogip., 2003a. Accidents de mission en Europe : quelle prévention ? Paris. Décembre 2003. Actes. 32 pp.
- Eurogip., 2003b. Le risque routier encouru par les salariés en Europe. Quelle ampleur ? Quelle prévention ? Eurogip. Octobre 2003. 43 pp.
- Hamon-Cholet, S., 2002. Accidents, accidentés et organisation du travail. Premières Synthèses. DARES. 2002, n°20.1. 10 pp.

[http://www.travail.gouv.fr/IMG/pdf/publication\\_pips\\_200205\\_n-20-1\\_accidents-accidentees-et-organisation-travail.pdf](http://www.travail.gouv.fr/IMG/pdf/publication_pips_200205_n-20-1_accidents-accidentees-et-organisation-travail.pdf)

Harrison, J.E., Mandryk, J.A., Frommer, M.S., 1993. Work-related road fatalities in Australia, 1982–1984. *Accid Anal Prev.* 25(4):443–451.

INSEE., 2007. National Institute for Statistics and Economic Studies. Répartition des postes salariés selon la taille de l'établissement au 31 décembre 2004 par région. Mise à jour 07/2007. <http://www.insee.fr/fr/ffc/figure/CMRnon09220.XLS>.

Laumon, B., Martin, J.L., Collet, P., Chiron, M., Verney, M.P., Ndiaye, A., Vergnes, I., 1997. A French road accident trauma registry: first results. In: 41st Annual Proceedings of the Association for the Advancement of Automotive Medicine, Orlando, Florida, pp. 127–137.

Massie, D.L., Green, P.E., Campbell, K.L., 1997. Crash involvement rates by driver gender and the role of average annual mileage. *Accid Anal Prev.* 29: 675-685.

NAF (Nomenclature d'Activités Française). Rev 1. 2003.

[http://www.insee.fr/fr/nom\\_def\\_met/nomenclatures/naf/pages/naf.htm](http://www.insee.fr/fr/nom_def_met/nomenclatures/naf/pages/naf.htm)

PCS (Professions et Catégories Socioprofessionnelles). 2003.

[http://www.insee.fr/fr/nom\\_def\\_met/nomenclatures/prof\\_cat\\_soc/pages/pcs.htm](http://www.insee.fr/fr/nom_def_met/nomenclatures/prof_cat_soc/pages/pcs.htm)

Pratt, S.G., 2003. Work-Related Roadway Crashes. Challenges and Opportunities for Prevention. DHHS (NIOSH) Publication 119. 108 p.

<http://www.cdc.gov/niosh/docs/2003-119/>

Peck, R.C., Kuan, J., 1983. A statistical model of individual accident risk prediction using driver record, territory and other biographical factors. *Accid Anal Prev.* 15 : 371-393.

Richez J.P, Tissot C., 2001. Le risque routier. Travail et Sécurité, octobre 2001, n°611, p16-35.

Rossignol, M., Pineault, M., 1993. Fatal occupational injury rates: Quebec, 1981 through 1988. Am J Public Health. 83(11):1563–1566.

Salminen, S., Lahdeniemi, E., 2002. Risk factors in work-related traffic  
Transportation Research Part F: Traffic Psychology and Behaviour. 5(1):77-86.

Stokes M., Rodriguez R. and Tobias R. A preview of SAS/STAT Version 9: Moving in new direction and building on old favorites. SUGI 27, Paper 257-27.

<http://www2.sas.com/proceedings/sugi27/p257-27.pdf>

Toscano, G., Windau, J., 1994. The changing character of fatal work injuries. Monthly Labour Review. 118:17–28.

Trent, R.B., 1989. Location of fatal work injuries in the United States: 1980 to 1985. J Occup Med. 31(8):674–676.

HMSO., 2004. Safety Culture and Work-Related Road Accidents. Road Safety Research Report No. 51. 134 p. [http://www.orsa.org.uk/guidance/pdfs/dft\\_safetyculture.pdf](http://www.orsa.org.uk/guidance/pdfs/dft_safetyculture.pdf)

**Table 1 : General characteristics of the study population**

<b>Sex</b>	<b>Cases (n=146)</b>		<b>Controls (n=440)</b>	
	<b>n</b>	<b>%</b>	<b>n</b>	<b>%</b>
<i>Men</i>	118	80.8	351	79.8
<i>Women</i>	28	19.2	89	20.2
<b>Class of age</b>				
<i>&lt;=29 yrs</i>	50	34.3	140	31.8
<i>[30 - 44]</i>	64	43.8	150	34.1
<i>&gt;=45 yrs</i>	32	21.9	150	34.1
<b>Place of residence</b>				
<i>Rhône</i>	114	78.1	347	78.9
<i>Other district of Rhône-AlpesRegion</i>	22	15.1	62	14.1
<i>Other districts of France</i>	10	6.8	31	7.0
<b>Victim of accident as</b>				
<i>Driver of car or commercial vehicle</i>	68	46.6		
<i>Driver of truck, bus, public transport</i>	32	21.9		
<i>Cyclist or motorcyclists</i>	27	18.5		
<i>Pedestrian</i>	19	13.6		

**Table 2: Distribution of road traffic exposure time**

Work time exposed to road risk (%)	Cases (n=146)		Controls (n=440)		OR	95% CI	p
	n	%	n	%			
0	17	11.6	234	53.2	1	–	<0.0001
<i>]0;10]</i>	14	9.6	95	21.6	2.30	1.08–4.91	
<i>]10;50]</i>	46	31.5	81	18.4	6.64	3.54–12.45	
<i>]50;100]</i>	69	47.3	30	6.8	36.84	16.84–80.59	

**Table 3: Distribution of socio-professional categories in cases and controls**

Category <sup>1</sup>	Cases (n=146)		Controls (n=440)		Raw OR	95% CI	Adjusted <sup>2</sup> OR	95% CI
	n	%	n	%				
<i>Self-employed (31), public sector executives, intellectual and artistic professions (32), corporate executives (36)</i>	8	5.5	111	25.2	1	-	1	-
<i>Middle-level jobs in teaching, health, public sector, and similar (41)</i>	8	5.5	45	10.2	2.28	0.78 - 6.71	3.12	0.84 - 11.57
<i>Middle-level administrative, commercial and corporate jobs (46)</i>	12	8.2	37	8.4	<b>4.79</b>	<b>1.75 - 13.07</b>	<b>4.64</b>	<b>1.47 - 14.66</b>
<i>Technicians (47), foremen, supervisors (48)</i>	7	4.8	61	13.9	1.86	0.62 - 5.54	2.25	0.67 - 7.49
<i>Public sector workers (51)</i>	33	22.6	37	8.4	<b>12.67</b>	<b>5.17 - 31.07</b>	<b>10.61</b>	<b>3.54 - 31.78</b>
<i>Company administration workers (54), shop workers (55), personal service workers (56),</i>	6	4.1	39	8.9	2.16	0.65 - 7.12	2.69	0.62 - 11.69
<i>Skilled workers (61), unskilled workers (66), agricultural labourers and similar (69)</i>	61	41.8	83	18.9	<b>12.09</b>	<b>5.10 - 26.67</b>	<b>8.57</b>	<b>2.92 - 25.19</b>
<i>Farmers (10), craftsmen (21), shopkeepers and similar (22), CEOs of companies with at least 10 employees (23)</i>	11	7.5	27	6.1	<b>6.07</b>	<b>2.09 - 17.61</b>	<b>5.71</b>	<b>1.68 - 19.43</b>

<sup>1</sup>INSEE terminology for professions and socio-professional categories (PCS)

<sup>2</sup>Adjustment on road traffic exposure time split into four categories

**Table 4: Distribution of job sectors in cases and controls**

NAF group <sup>1</sup>	Cases (n=146)		Controls (n=440)		Raw OR	95% CI	Adjusted <sup>2</sup> OR	95% CI
	n	%	n	%				
<i>Extraction; manufacturing; electricity, gas and water production and distribution; construction (C, D, E, F)</i>	23	15.7	129	29.3	1	-	1	-
<i>Transport and communications (I)</i>	52	35.6	40	9.1	<b>7.19</b>	<b>3.78 - 13.68</b>	<b>4.47</b>	<b>1.99 - 10.04</b>
<i>Shops and restaurants (G, H)</i>	22	15.1	64	14.5	<b>2.09</b>	<b>1.04 - 4.21</b>	4.83	0.79 - 4.18
<i>Real estate; corporate rentals and services (K)</i>	12	8.2	59	13.4	1.22	0.54 - 2.75	1.22	0.47 - 3.16
<i>Public administration; education; health; social services (L, M, N)</i>	30	20.6	112	25.5	1.44	0.76 - 2.71	1.65	0.79 - 3.45
<i>Agriculture, hunting and forestry; fishing, fish breeding and associated services; finance; collective, social and personal services; household services A, B, J, O, P)</i>	7	4.8	36	8.2	1.11	0.44 - 2.80	1.12	0.37 - 3.43

<sup>1</sup>INSEE French Business Terminology (NAF)

<sup>2</sup>Adjustment on road traffic exposure time split into four categories

**Table 5: Company size**

	Cases (n=146)		Controls (n=440)		Raw OR	95% CI	Adjusted <sup>1</sup> OR	95% CI
	n	%	n	%				
<b>Number of employed in site</b>								
>100	28	20.1	149	35.2	1	–	1	–
10 - 99	67	48.2	172	40.7	<b>2.12</b>	<b>1.28 – 3.51</b>	1.04	0.54 – 2.03
<10	44	31.7	102	24.1	<b>2.24</b>	<b>1.31 – 3.85</b>	1.09	0.53 – 2.22
<b>Number of employed in company</b>								
>500	50	34.7	221	51.0	1	–	1	–
50 - 499	36	25.0	88	20.3	<b>1.81</b>	<b>1.10 – 2.96</b>	1.34	0.73 – 2.47
<50	58	40.3	124	28.7	<b>1.96</b>	<b>1.25 – 3.08</b>	1.28	0.72 – 2.28

<sup>1</sup>Adjustment on road traffic exposure time split into four categories



**Table 6: Seniority in company, job and type of job**

	All	Cases (n=146)		Controls (n=440)		Raw OR	95% CI	Adjusted <sup>1</sup> OR	95% CI
	n (%)	n	%	n	%				
<b>Seniority in job</b>									
> 10 years	125 (21.3)	26	17.8	99	22.5	1	–	1	–
3 - 10 years	123 (21.0)	30	20.6	93	21.1	1.53	0.79 – 2.94	1.03	0.45 – 2.40
1 - 3 years	174 (29.7)	39	26.7	135	30.7	1.33	0.71 – 2.48	1.13	0.53 – 2.39
< 1 year	164 (28.0)	51	<b>34.9</b>	113	25.7	<b>2.09</b>	<b>1.09 – 3.98</b>	1.77	0.79 – 2.93
<b>Seniority in type of job</b>									
> 17 years	140 (23.9)	31	21.2	109	24.8	1	–	1	–
7 - 17 years	139 (23.7)	29	19.9	110	25.0	1.07	0.57 – 2.01	1.05	0.48 – 2.27
3 - 7 years	144 (24.6)	30	20.5	114	25.9	1.42	0.69 – 2.91	1.38	0.55 – 3.43
< 3 years	163 (27.8)	56	<b>38.4</b>	107	24.3	<b>2.98</b>	<b>1.45 – 6.09</b>	<b>3.20</b>	<b>1.25 – 8.00</b>
<b>Seniority in company</b>									
> 12 years	144 (24.6)	28	19.2	116	26.4	1	–	1	–
4 - 12 years	123 (21.0)	26	17.8	97	22.0	1.29	0.67 – 2.50	0.93	0.42 – 2.07
2 - 4 years	117 (20.0)	23	15.7	94	21.4	1.37	0.67 – 2.82	0.98	0.41 – 2.38
< 2 years	202 (34.4)	69	<b>47.3</b>	133	30.2	<b>3.08</b>	<b>1.63 – 5.82</b>	2.13	0.96 – 4.74

<sup>1</sup>Adjustment on road traffic exposure time split into four categories